AFRL-VA-WP-TR-2006-3098

SENSORCRAFT - SIMULATION-BASED RESEARCH AND DEVELOPMENT

The Wright Brothers Institute, Inc.
5100 Springfield Pike, Suite 500
Dayton, OH 45431

MARCH 2006

Final Report for 01 March 2003 – 15 June 2005

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14. ABSTRACT
This project was to enhance the process used by AFRL/VA to assess new technologies by facilitating connectivity between people and analysis tools, and between the tools themselves. This was accomplished by addressing the technology and processes that will have the greatest impact on the ability of a technology assessment project team to accomplish its goals, implementing commercial off-the-shelf (COTS) software solutions whenever possible. The overall project was divided into three sections. These were performed by UDRI, Boeing, and Georgia Tech. The processes developed were used in some demonstrations that were delivered to the government under separate cover due to the sensitivity of the information. This report briefly describes the activities performed under this collaborative project order.

15. SUBJECT TERMS
SensorCraft, Simulation-Based R&D, Unified Geometry, Data Repository, Accelerated Analysis

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Wright Brothers Institute
Energizing Collaborative R&D

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The views and conclusion contained herein are those of the author and should not be interpreted as necessarily representing the official policies or endorsements, either expressed or implied, of the Air Force Research Laboratory.

Wright Brothers Institute

This study was done under the direction of The Wright Brothers Institute, Inc. (WBI) of Dayton, Ohio under a Partnership Intermediary Agreement and a Collaborative Project Order issued under its authority.

The vision of WBI is to enhance the nation's global dominance in air and space by revitalizing its core competencies in aerospace science, technology, engineering and design integration. WBI sees as its mission to create, implement and support world-class R&D collaborations among the best scientists and engineers from government, industry, and academia that leverage a variety of resources to benefit all participants.[1]

Restoring national dominance in aerospace technology is the driving force behind the Wright Brothers Institute. Our nation's leadership role in the aerospace industry is currently at risk due to reduced government funding for aerospace programs, a dramatic decrease in aerospace-related university graduates, and a declining industrial base doing less long-term research. The Wright Brothers Institute seeks to reverse this trend and re-establish the United States as the dominant worldwide entity in aerospace science, technology, engineering and design integration.

Publication Date: June 30, 2005

[1] Wright Brothers Institute at http://www.wrightbrothersinstitute.org.

Wright Brothers Institute
Energizing Collaborative R&D

SUMMARY

This Collaborative Project Order (CPO) was to enhance the process used by Air Force Research Laboratory Air Vehicles Directorate (AFRL/VA) to assess new technologies by facilitating connectivity between people and analysis tools, and between the tools themselves. This was accomplished by addressing the technology and processes that will have the greatest impact on the ability of a technology assessment project team to accomplish its goals, implementing commercial-off-the-shelf (COTS) software solutions whenever possible.

The overall Collaborative Project Order (CPO) was divided into three individual tasks. These tasks were carried out by the University of Dayton Research Institute (UDRI), The Boeing Company, and the Georgia Institute of Technology Aerospace Systems Design Laboratory (ASDL). The following summarizes each of these task efforts with the individual reports attached after this summary.

1. The overall goal of the UDRI effort was to enhance the process used by the Air Force Research Laboratory Air Vehicles Directorate (AFRL/VA) to assess new technologies by facilitating connectivity between people and analysis tools, and between the tools themselves. This was accomplished by addressing three areas of the technology and processes that have the greatest impact on the ability of a technology assessment project team to accomplish its goals; Unified Geometry, Common Analysis Environment, and Data Repository implementing commercial-off-the-shelf (COTS) software solutions were implemented whenever possible. (See Attachment 1 for the full report.)

The UG task goal was to develop a capability to transform, manipulate, and make available different forms and complexities of geometries in a way that is compatible with different software tools, regardless of format.

The CAE is enhancing the technology assessment capabilities within AFRL/VA. This environment promotes seamless integration with external organizations such as the Propulsion Directorate (AFRL/PR) through a single environment, thus promoting AFRL-wide collaboration and reducing the assessment and development time by integrating the tools into a process oriented environment and tying information on disparate servers into one interface.

The DR objective created a utility for information storage, retrieval, and sharing. Under this task, a collaborative environment was used as the infrastructure for this proof-of-concept. Besides creating the structure and foundation of the DR, this task created the policies and procedures to implement and manage the DR. The end result is a collaborative environment that is being utilized on multiple programs and the ability to archive and retrieve both tools and data.

2. The Boeing Company focused on four different aspects of the Air Force Research Lab (AFRL) Vehicle Assessment (VA), Wright Brothers Institute (WBI) collaboration program. These four aspects covered a broad range of issues that are being pursued within the aerospace industry, and especially focused on research thrusts and related problems encountered at the AFRL-VA/WBI. These were:

A. Geometry Conversion
   Conversion in accepting and utilizing “legacy” CAD model data from industry; and conversion of a University of Dayton Research Institute (UDRI) wind tunnel model into a CFD gridder compatible model.
B. Accelerated Analysis
   Acceleration through using Common-Off-The-Shelf (COTS) tools, such as Phoenix Integration’s Model Center and Engineous Software’s iSIGHT multi-disciplinary optimization (MDO) environments, and how they could be integrated with one of their tools

FLight Optimization and Programmed Simulation (FLOPS). Another simulation code that was considered was AirCraft SYNThesis (ACSYNT), which has been highly utilized within the aerospace industry.

C. Analysis and Geometry Development
Focused the AFRL-VA/WBI in the realm of Analysis and Geometry Development regarding the Long Range Strike (LRS) program. The user community was interested in methodologies that would allow rapid analysis and geometry creation.

D. Hypersonics
The AFRL-VA/WBI investigated the latest developments concerning Hypersonic Level 0 sizing tools. As a simulation code, this too could be later considered for integration with MDO environments, as well as geometry tools.

A number of potential projects are listed in this presentation in order to provide some glimpse as to where future thrusts may lie.

The initial pages explaining this task are shown in the briefing charts in Attachment 2. However, due to the use of proprietary data in this part of the study, AFRL/VA had the report submitted under a separate cover and approved per Dennis L. Carter, AFRL/VAAA, on June 21, 2005.

3. The objective of the Georgia Tech ASDL portion of this Collaborative Project Order (CPO) was to quickly assess competing technologies on a systems level to support decision-making.

This activity integrated AFRL/VA analysis tools into a commercial set of software that creates an analysis environment(s). This activity placed the Air Force Research Laboratory's Air Vehicles directorate (AFRL/VA) in a strategic position to leverage recent advances in capable software and technology assessment methodology (TAM) to enable enhanced technology investment planning (TIP) and risk reduction efforts. Extraordinary work was done in the academic arena in TAM, and effort was needed in mastering and implementing these processes in AFRL/VA. The initial pages explaining this task are shown in the briefing charts in Attachment 3. However, due to the use of proprietary data in this part of the study, AFRL/VA had the report submitted under a separate cover and approved per Dennis L. Carter, AFRL/VAAA, on June 10, 2005.

Finally, the WBI would like to acknowledge the collaborative support of the Wright State University and TechnoSoft Inc. who were subcontractors to UDRI as well as to the Boeing Company for their in-kind contributions to this project. Their support leveraging their efforts in-house design activities and personnel costs increased the total contract value by their contributions totaling $794,750.18.

Attachment 1

University of Dayton Research Institute Report

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UDRI
UNIVERSITY of DAYTON RESEARCH INSTITUTE

UDR-TR-200500040

WRIGHT BROTHERS INSTITUTE - SIMULATION BASED RESEARCH AND DEVELOPMENT (WBI-SBRD)

FINAL REPORT

February 2005

Allen R. Revels
Thomas Held
William Braisted, Ph.D.
Kevin Roach
Clarence W. Cross, Jr.

Technical Report

NOTICE

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UDR-TR-200500040

Wright Brothers Institute - Simulation Based Research and Development (WBI-SBRD)

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Final Report

December 2004

Submitted to:
Mr. Stephen Zemanek
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Foreward

This report summarizes the accomplishments of the three tasks developed under the Wright Brothers Institute's Simulation-Based Research and Development (SBRD) Program contract WBS-9002 (July 2003 through December 2004). This provides an overview of the Unified Geometry (UG), Common Analysis Environment (CAE), and Data Repository (DR) tasks. This effort was done for technology assessment for the Air Vehicles Directorate of the Air Force Research Laboratory (AFRL/VA).

This effort was led through the Aerospace Mechanics Division (Michael P. Bouchard, Division Head) of the University of Dayton Research Institute (UDRI). The Air Force Project Manager for this effort was Mr. Dennis Carter, AFRL/VA Aerodynamic Configuration Branch (AFRL/VAAA). Mr. Stephen Zemanek provided WBI technical and programmatic support.

The UDRI Principal Investigator was Allen R. Revels. Additionally, technical work was done with the Information Technology Group (Clarence W. Cross, Jr.) and Structures Group (Thomas J. Held and William R. Braisted) at UDRI in conjunction with TechnoSoft, Inc., James Gregory Associates, Inc., and Wright State University.

Special notice should be given for the efforts of David Brown and Denis Mrozinski (AFRL/VA Technology Assessment Office) for their support of past and future efforts in Sim-Based Research and Development.

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Executive Summary

This report covers the three tasks developed under the Wright Brothers Institute's Simulation-Based Research and Development (SBRD) Program contract WBS-9002. This provides an overview of the Unified Geometry (UG), Common Analysis Environment (CAE), and Data Repository (DR) tasks.

The overall goal of this effort was to enhance the process used by AFRL/VA to assess new technologies by facilitating connectivity between people and analysis tools, and between the tools themselves. This was accomplished by addressing three areas of the technology and processes that have the greatest impact on the ability of a technology assessment project team to accomplish its goals; Unified Geometry, Common Analysis Environment, and Data Repository implementing commercial-off-the-shelf (COTS) software solutions were implemented whenever possible.

The UG task goal was to develop a capability to transform, manipulate, and make available different forms and complexities of geometries in a way that is compatible with different software tools, regardless of format. The approach to this task was an integrated effort with AFRL, UDRI, and TechnoSoft, Inc. A proactive approach using demonstrations, utilization within the laboratory, and feedback was used to create a viable solution. The result was a product from TechnoSoft, Inc called AMRaven. This program provides an interface to manipulate aircraft geometries at different levels of fidelity and is being utilized in the day-to-day operations of the organization. Continuing development to enable additional capabilities in the future is recommended.

The CAE task was comprised of three major subtasks: (1) define the AFRL/VA analysis process down to level of detail required for analysis implementation; (2) assess the capabilities of two commercially common analysis environments; and (3) demonstrate the resulting automated analyses with two case studies. The CAE is enhancing the technology assessment capabilities within AFRL/VA. This environment promotes seamless integration with external organizations such as the Propulsion Directorate (AFRL/PR) through a single environment, thus promoting AFRL-wide collaboration and reducing the assessment and development time by integrating the tools into a process oriented environment and tying information on disparate servers into one interface.

The DR objective created a utility for information storage, retrieval, and sharing. Under this task, a collaborative environment was used as the infrastructure for this proof-of-concept. Besides creating the structure and foundation of the DR, this task created the policies and procedures to implement and manage the DR. The end result is a collaborative environment that is being utilized on multiple programs and the ability to archive and retrieve both tools and data.

Overall, the program has enhanced the technology assessment capabilities by effectively integrating processes and functions into a collaborative workspace that utilizes process automation.

1. OVERVIEW

At the urging of Air Force (AF) leaders, technology advocates, policy makers and former AF officers, a series of internal and external studies were conducted to determine how to reinvigorate the activities the principal R&D and engineering enterprises of Wright-Patterson Air Force Base (WPAFB), the Air Force Research Laboratory (AFRL) and Aeronautical Systems Center (ASC), respectively. Based on these studies, AFRL and ASC funding and activities could be reinvigorated through increased collaboration with world-class researchers and visionaries. Furthermore, an agile and highly motivated workforce operating in an entrepreneurial and responsive environment would increase the value that AFRL and ASC bring to the AF warfighter. Partnerships that leveraged AF funding to create value for the AF and traditional and non-traditional partners would expand WPAFB's customer base and increase the credibility of its programs. Finally, transitioning technology to the warfighter and transferring technology to the private sector would have to be more efficiently accomplished to create better value.

The initial work in this area culminated in the Simulation Based Research and Development (SBRD) Investment Strategy and Plan (Revels and Gentner, 2004). The vision of SBRD is to have a complete integrated environment, which allows connectivity between the conceptual design through mission simulation up to campaign simulation. Internally to AFRL's Air Vehicles Directorate (AFRL/VA), this vision will allow the incorporation of experimental data, conceptual design tools and a geometry tool to transfer data into the mission simulation through a data repository (Figure 1).

This strategy laid out a schedule of events for implementation over the next five years. For the initial two years, the strategy focuses on the implementation and integration of tools within AFRL's technology assessment processes. Specifically, this strategy emphasized an initiative that includes the implementation of a unified geometry tool, a common analysis environment, and the data repository.

The strategic intent is to implement the processes through a series of pilot programs or projects. This approach allows the incremental integration and application of capabilities to current programs while receiving feedback to improve the tools, processes, or overall capabilities. The end-user involvement helps in the acceptance of the new approach and gives ownership to the participants. This allows a smooth transition in the cultural shift in the organization.

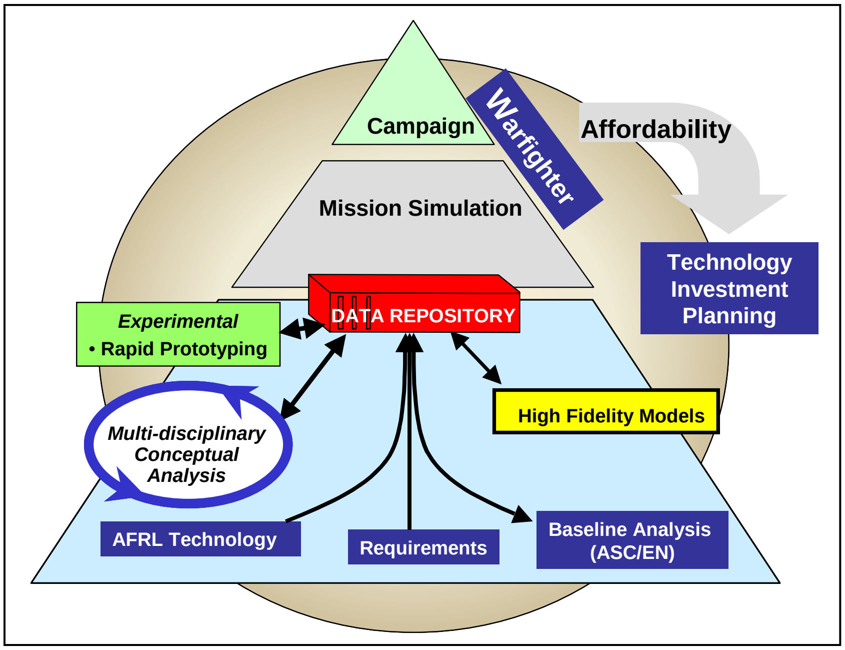

Figure 1 Air Vehicles Technology Assessment Process

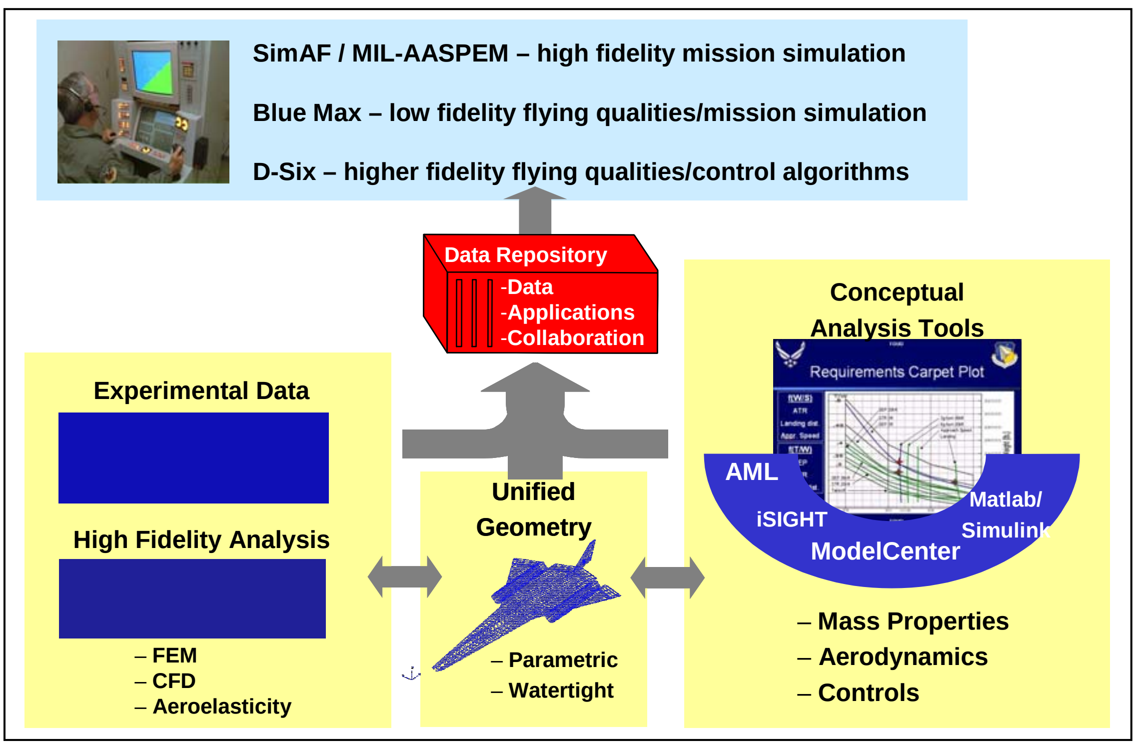

Figure 2 Vision for Process Integration

2. OBJECTIVES AND SCOPE

The overall goal of this effort was to enhance the process used by AFRL/VA to assess new technologies by facilitating connectivity between people and analysis tools, and between the tools themselves. This was accomplished by addressing the three areas of technology and processes that have the greatest impact on the ability of a technology assessment project team to accomplish its goals: unified geometry, common analysis environment and the data repository. Commercial-off-the-shelf (COTS) software solutions were implemented whenever possible.

The technology assessment enhancements were accomplished through three (3) distinct areas. These crucial elements covered under this effort included:

1. Unified Geometry (UG)

2. Common Analysis Environment (CAE)

3. Data Repository and Collaborative Environment (DR)

Unified Geometry enables a single geometry definition and format for a variety of multi-disciplinary analysis tools. The Common Analysis Environment allows a variety of multi-disciplinary analysis tools to interact in an automated engineering environment. The Data Repository and Collaborative Environment permits project teams to seamlessly share data and ideas on a project and provides a place to archive data for future use. In each of these areas, COTS software solutions were used to accomplish these objectives, and document the strategy, implementation, results, and recommendations.

Enabling these capabilities was not the only objective. The utilization and acceptance of the tools are just as, if not more, important. Therefore, the participation of all of the organizations involved in technology assessment and aero configuration was essential to the success of the project. This had a significant impact on the approach that was taken to accomplish the stated objectives within the Simulation Based Research and Development Investment Strategy and Plan. (Revels & Gentner)

3. APPROACH

This effort was accomplished with a team approach as a collaboration with the government, industry, and academia. The members included the Air Force Research Laboratory's Air Vehicles Directorate (AFRL/VA), the University of Dayton Research Institute (UDRI), TechnoSoft Inc. (TSI), James Gregory Associates, Inc. (JGAI), and Wright State University (WSU) (Figure 3).

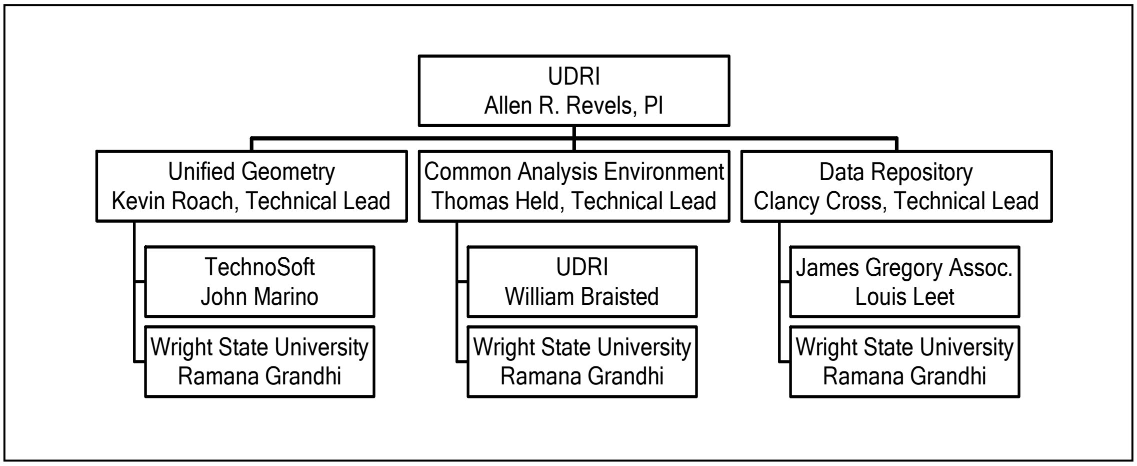

Figure 3 Team Organization

Each team member had specific roles and responsibilities contributing to the overall success of the program. UDRI served as the overall program lead and was responsible for the administration and technical accomplishments on each of the tasks. TechnoSoft, Inc (TSI) provided the development of the UG software and components with Wright State University exercising the environment. Under the CAE task, UDRI developed the demonstrations and evaluated the environment while WSU developed the data dictionary. The DR required software provided by James Gregory Associates, Inc. (JGAI). Additionally, JGAI developed and integrated the DR components with WSU collecting and storing data. UDRI developed the policies and procedures for DR operations. Each team member worked in close conjunction with AFRL/VA through the leadership of the Aeronautical Configuration Branch (VAAA) and UDRI.

4. TASKS

This report serves as an overview of the accomplishments, conclusions, and recommendations for each of the three tasks that were accomplished under this contract. Details of each task is covered in separate reports:

- Unified Geometry (Roach, 2005)
- Common Analysis Environment (Held & Braisted, 2005)
- Data Repository (Cross, Vaidya, & Revels, 2005)

4.1 Unified Geometry

The current technology assessment process includes modeling and interface inefficiencies. These include the different geometry definition requirement for the different analysis tools currently being used. A significant amount of engineering time is spent "redeveloping" these geometries (Revels & Gentner).

The objective of this task was to develop an interface and functionality that is appropriate for unifying the geometry and thereby enhancing the communications between level 0, level 1, and level 2 analysis tools (Figure 4). The Unified Geometry (UG) was designed to address these inefficiencies by developing a single foundation for the geometric models. This environment supports different levels of geometric fidelity as well as being able to support different analysis tools.

The COTS tool to be refined and implemented for this task was TechnoSoft Inc.'s (TSI) AMRaven (Adaptive Modeling Rapid AirVehicle ENvironment) based on TSI's Adaptive Modeling Language (AML). The selection of this product was based on its potential to be developed and utilized. Additionally, the product was chosen based on its object-oriented architecture using a parametric design environment, giving the final parametric object a "smart" geometric capability. This capability allows the product to read multiple formats and output formats compatible with various software (Roach).

Under this task, several requirements were attained to conclude with a successful program. The subtasks included the development of a COTS modeling environment containing a graphical user interface, the development of baseline aerospace vehicle models that are suitable for use with conceptual and high-fidelity analysis tools, support for common standards for geometry, definition of model information, and exchange of parameters between various tools and environments (when necessary).

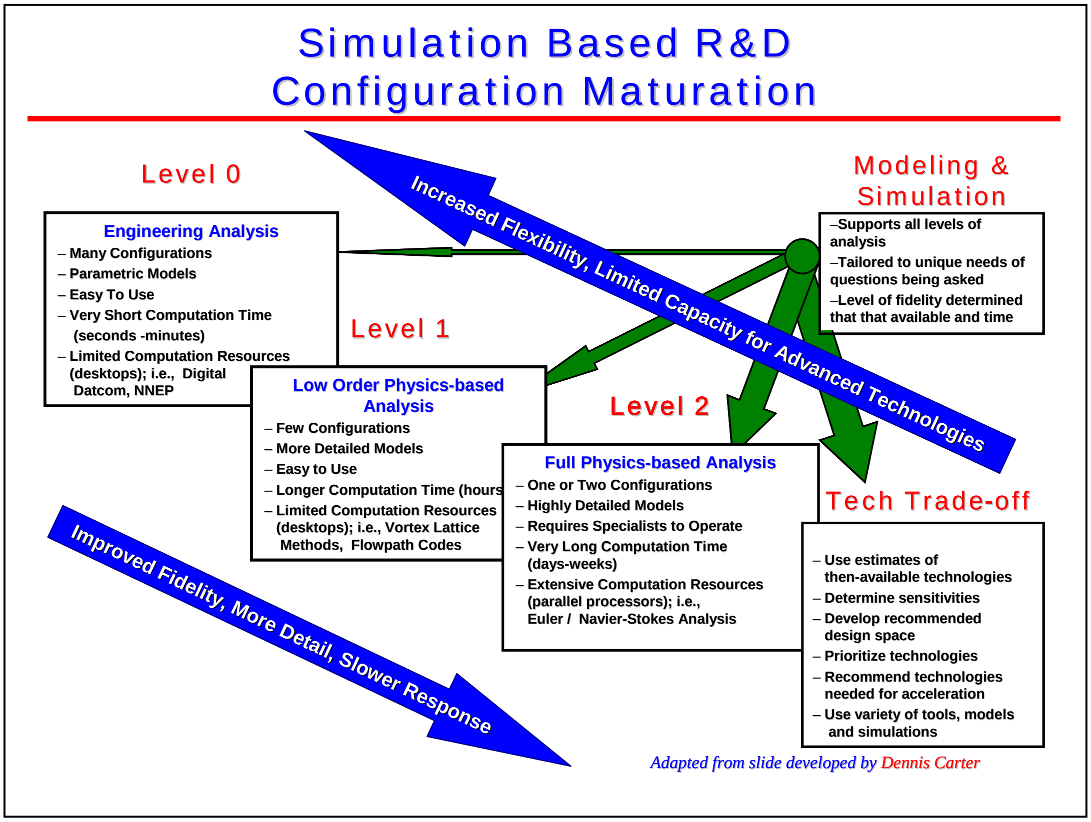

Figure 4 SBRD Configuration Maturation

In past programs, the acceptance of new methods or tools was met with some resistance. An approach to creating ownership within the user community had to be employed. This was accomplished with periodic demonstrations of the AMRaven. During these sessions, a critique of the product along with issues was discussed. Each session produced a list of improvements. With AFRL/VA input, each item was ranked ordered and balanced against cost and schedule limitations. From that list, improvements to the product were made to AMRaven. Leveraging off of development in other programs, other areas that were noted were also solved. In essence, there was a synergistic effect between the programs and the accomplishments that were achieved.

As required by the objectives, this task worked on two divergent models: Sensor Craft and Blended Wing Body (BWB). Each posed many challenges which are covered in Unified Geometry Final Report (Roach). By using these examples, the use of Level 0 and Level 1 geometries were fed into a Level 2 development as specified in the objectives.

The effectiveness of AMRaven could only be measured by integrating this tool into the processes utilized by AFRL/VA. As AMRaven was being developed, a concurrent process of integration was taking place. Under the Unified Geometry (UG) task, AMRaven was successfully wrapped into the CAE environment.

Overall, AMRaven was well received by the AFRL/VAAA users that were part of the Unified Geometry team. Not only did the users step right up and start using AMRaven, they were asked to demonstrate the software to other AFRL organizations and high-ranking visitors during the development stages.

Simply put, AMRaven is a software tool that met all the objectives of the Unified Geometry task, and shows much promise as a useful technology assessment modeling tool. There are also opportunities for improvement, both in the developed software, and in the way in which organizations utilize the knowledge-based engineering (KBE) approach to a design tool application. Although the Unified Geometry effort was not multi-phased, it is recommended that a follow-on effort be initiated for continued AMRaven development.

4.2 Common Analysis Environment

Design, optimization, and assessment of advanced air vehicle concepts have traditionally been a laborious and time-consuming process. This is in large part due to the multi-disciplinary nature of the problem in which aerodynamics, propulsion, structural integrity, mission performance, stability/control, life cycle cost, and other issues have been addressed one after another in a serial manner. At each step in the analysis process a large amount of data must be manually regenerated and reformatted because these technical disciplines often use different tools, file formats, unit systems, and parameter definitions. Having to regenerate a significant amount of data at each step makes the overall process extremely slow. Furthermore, since all the steps are executed in a serial fashion there is little opportunity to assess trades between technical disciplines (Held & Braisted).

The ability to integrate these activities is critical to make better technology investment decisions in a timely manner. The time to transition technology solutions from the conceptual design phase to implementation must decrease to put the best technology and capabilities into the hands of the end-user. One key technology that will allow these tools, processes, and data to interact effectively is a Common Analysis Environment (CAE).

The CAE provides the backbone of future analysis by establishing an automated procedure to enhance integration of tools, data, and processes into a single integrated environment. The objective of this effort was to define and create an analysis process that incorporated existing AFRL/VA conceptual design and analysis tools and integrate them into a commercially available analysis environment.

The CAE task was comprised of three major subtasks: (1) define the AFRL/VA analysis process down to level of detail required for analysis implementation; (2) assess the capabilities of two commercially common analysis environments; and (3) demonstrate the resulting automated analyses with two case studies.

In defining the analysis process, it was concluded that the majority of the AFRL/VA design and technology assessment fell into three major processes: low-speed or subsonic, high-speed or low supersonic, and hypersonic. In conjunction with the Air Force, the low-speed and high-speed processes were demonstrated via case study. Details are covered in CAE Final Report (Held & Braisted). Leveraging off of this effort, these configurations were used for the CAE assessment.

The capabilities assessment compared two COTS design environment tools: ModelCenter (Phoenix Integration) and iSIGHT (Engineous Software). These two tools allow the engineering process to be encapsulated into a single environment (Figure 5). The CAE manages data flow and process automation between what were once independent technical areas. Additionally, the CAE provides a mechanism to generate data for higher fidelity aircraft geometries and parameters outside the environment.

At a high level, implementation of an analysis process within either of the CAE modeling environments, ModelCenter and iSIGHT, is very similar. However, there is a significant difference between how the two environments manage and integrate data, the ease of model setup, and the ability to run models.

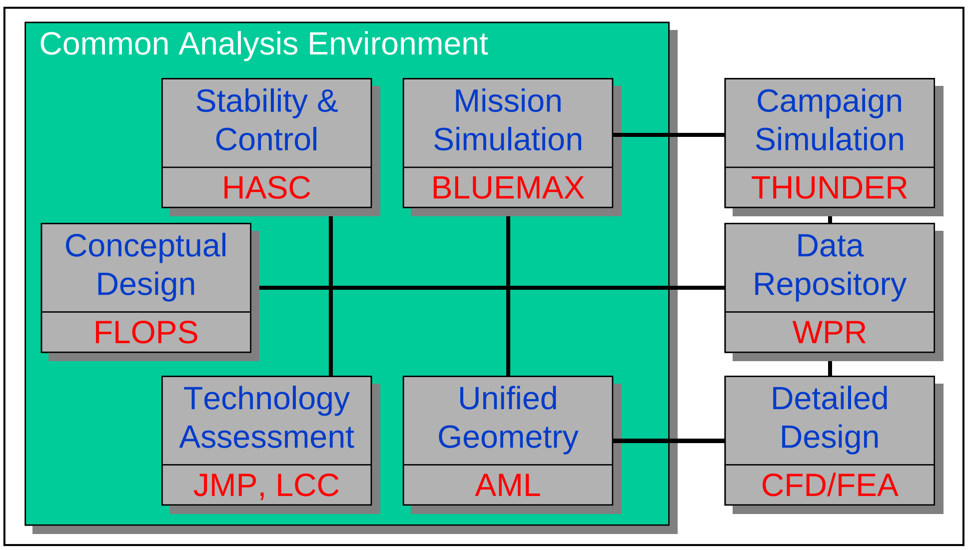

Figure 5 Sample CAE Environment

The CAE tool recommendation was based on the usability and applicability for the processes that are pertinent to the AFRL/VA technology assessment processes. There were two case studies performed in ModelCenter and one in the iSIGHT environments. These studies were based on current projects of interest to the laboratory. In the end, both environments functioned effectively and either tool could be used to perform the assessment activities. Based on criteria such as usability, data organization, and network computing capability, ModelCenter was the recommended choice for the AFRL/VA.

In conjunction with the evaluation, demonstrations of the environment were performed using the Future Tanker and the Future Strike concepts (Braisted & Held). One of the demonstrations was also able to capture work done under the UG task using AMRaven.

These demonstrations showed the successful implementation of the CAE utilizing both legacy tools with newly developed tools in a single environment. This allowed the electronic transfer of data, information, and results from process to process. In addition, the CAE linked the design processes with modeling simulations, such as BLUEMAX, early in the development enabling efficient and effective iterations in the design processes. In essence, it allowed the designer or design evaluator to assess multiple designs and significantly shortens the period from air vehicle concept to actually “flying” a design in a simulation.

An additional achievement was a study of methods to pass technology assessment information from one Directorate to another. This was beyond the scope of this effort but was a concept that spawned from the question “how can we make the system more effective for our processes.” In this case, “Can information from AFRL/VA be utilized by developers in another Directorate such as the Propulsion Directorate (AFRL/PR) and vice-versa?” Although the concept may seem trivial, the implementation was much more challenging.

In the study, three models of information exchange were discussed: Local, Cross-Directorate, and Integrated (Held & Braisted). In the local model, the server information is accessed only within a local directorate. This is how business is done today. If information is shared, it must be copied and sent to the other directorate to be added to their installation. In the Cross-Directorate model, users in another directorate can access information on one server. This is a direct connection to the single server. The final concept is an integrated one in which either server can be accessed by either directorate. During this task, a cross-directorate connection was achieved and demonstrated.

The overall effort demonstrates the value of using a common analysis environment in the technical assessment process: the CAE manages complicated process execution and data processing; permits review of a large number of concepts; compresses the time needed to perform an assessment from weeks into hours and connect together all the AFRL organizations that participate in the technology assessment process.

4.3 Data Repository

Data and information is the key link between the effective and efficient use of knowledge, tools, and human resources. For AFRL/VA to be able successfully utilize the previously described UG and CAE capabilities, the information generated and shared by these tools must be stored in an environment in which is readily accessible and secure. This information link is termed the Data Repository (DR). The data repository allows the transfer of information between the design level and the mission simulation level of the Air Vehicle Technology Assessment Process (Figure 6).

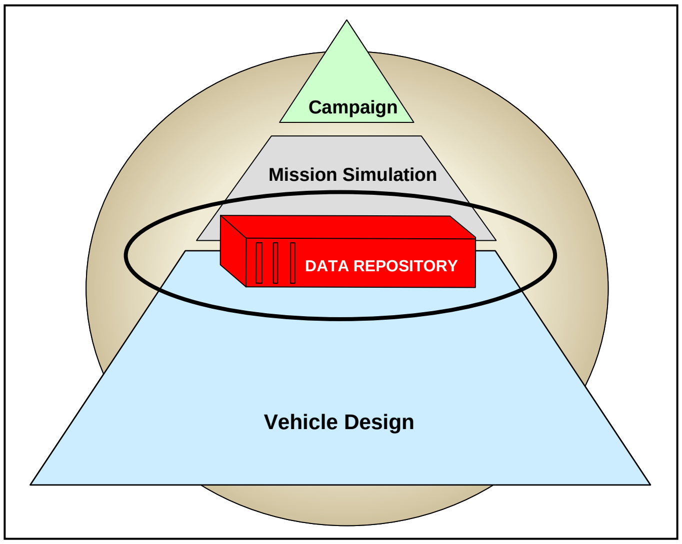

Figure 6 Data Repository in Assessment Process

Several requirements were established for the DR Task. The first was to set up the initial data definitions, structure, methodologies, policies, and seed information (Figure 7). The second was to incorporate project and data wizards to serve as an interface to the engineer to facilitate data storage, integrity, and structure. Third, a parasolids viewer needed to be integrated into the DR to allow the viewing of geometric data without hosting the software on the local computer. Finally, the DR should provide the ability to offer a common access point to current tools through Web Project Rooms (Revels & Gentner, 2004).

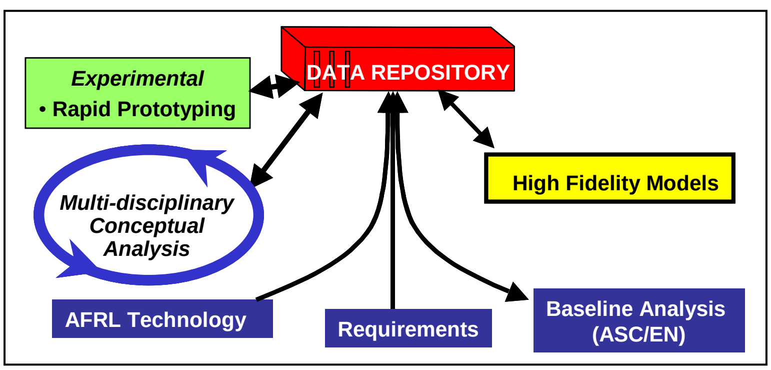

Figure 7 Data Repository and Sample Components

The initial task required the acquisition of a COTS "Networked Collaborative Engineering Framework." The selected resource was a product from JGAI called Web Project Room (WPR). This environment met the strict guidelines for security to be implemented on AFRL computing resources. In this case, however, the server was not collocated but housed at JGAI's Columbus, OH office. This framework allowed project teams to store and access to all necessary files, applications, and data resources that are specific to their research projects via the "Librarian"—a web-based repository and configuration management tool (Cross, Vaidya, & Revels).

Once WPR was established, WSU took on the responsibility to populate the data repository. The information was collected through a series of searches through established libraries and engineer's personal files. In addition, a series of interviews were conducted to establish what information was the most pertinent and should be added to the initial data repository (Cross, Vaidya, & Revels).

During this program, several projects within AFRL/VA utilized the features and functions of the base WPR software for collaboration. Each of the functional areas of this program also had a WPR set for use. (Figure 8) This collaborative environment showed that this implementation was not only feasible but also useful in accomplishing the individual project goals (Cross, Vaidya, & Revels).

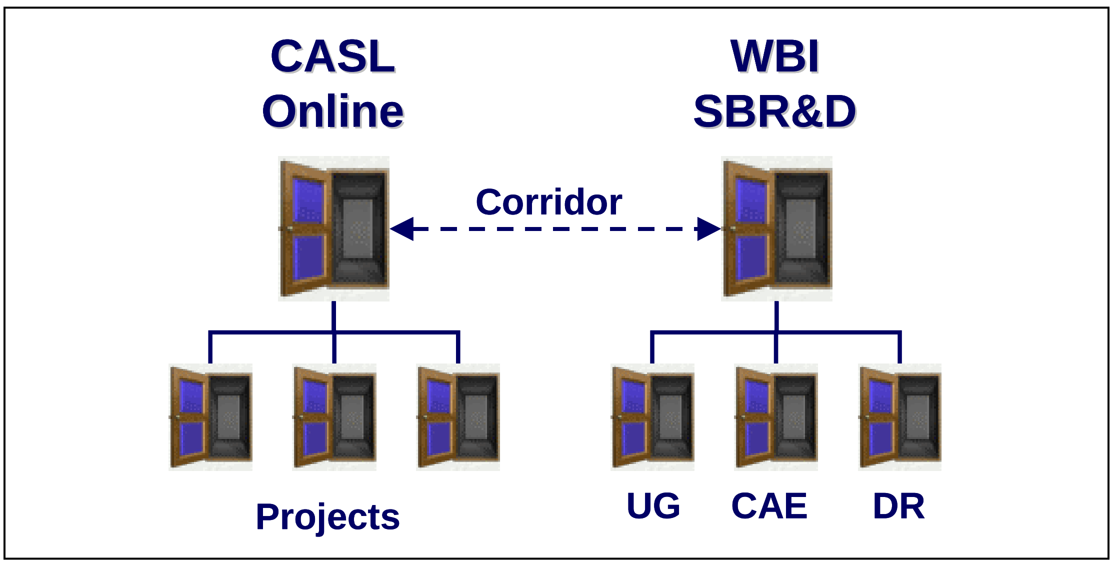

Figure 8 Web Project Room Setup

The intent of the parasolid viewer requirement was to facilitate the identification and selection of parasolid data stored in the repository. An integrated parasolid viewer would allow the user to display portions of parasolid files to identify the desired file(s) before performing a download.

The requirements included the following:

- It must be possible to integrate the viewer within the repository such that it does not require a complex install process before it could be used. The auto-install process used by JGAI's Secure Web Window was used as the benchmark for acceptability, since it had already been granted government approval.
- Interactively rotate the image and render different views of the parasolid model.
- Ability to process parasolid formats commonly used by VA.

- Client-side software components must be domestically produced.
- A software licensing policy that fit within the available budget.

A review of available commercial solutions was conducted. Available solutions were ranked and identified according to the requirements. A technical evaluation determined that a client-side solution would achieve better performance, but would create integration challenges related to installation of the client-side component. After narrowing the list down to three candidates, the team selected a client-side solution by TechnoSoft Inc. This component met all of the requirements. However, the automatic download/install capability was not developed during this proof-of-concept project. The proof-of-concept demonstration was conducted on a laptop computer that was preloaded with the viewer module.

The methodologies developed for searching the DR are defined in Cross, Vaidya, and Revels. There was an extensive design to the data structure and metadata for storage of information. This structure facilitates the ability to contextually search the repository for pertinent information.

To facilitate this process, wizards were developed to help the engineer to input the data into the DR. With the use of this tool, very little addition effort is required to ensure the proper information is included for future searches.

To enable a link to the other environments, a simple link was employed to SBAAT and the VAES. A more integrated approach to this endeavor was envisioned, however, due to limitations such as access to SBAAT, a simple link to launch the environment was implemented.

Proper policies and procedures were needed to govern the operations of the system. The challenge to writing these policies was that it was very dependent upon the regulations, policies, and procedures already established within AFRL/VA. These documents included Air Force Regulations, Air Force Material Command, Wright Patterson Air Force Base, 88th Communications Group, Aeronautical Systems Command, and AFRL regulations, policies, and procedures. This had to be weighed against the industry's best practices. This information is contained in DR Final Report (Cross, Vaidya, & Revels).

In addition to the requirements, a comparison of WPR against other commercially available products was accomplished. Specifically, WPR was compared to Microsoft's Share Point software. (Table 1) Complete results are published in the DR Final Report. (Cross, Vaidya, & Revels)

Table 1 Comparison Matrix WPR versus Share Point

Product Features	JGA (Web Project Room)	Microsoft (Share Point Services)
Document upload/download	Yes	Yes
Basic document management	No	Yes
Document version control	No	Limited
Collaboration environment	Yes	Yes
Participation in live meetings	SWW ™	Live Meeting ®
SSL (Secured Sockets Layer)	Yes	Yes
Threaded discussion lists	No	Limited
Web interface	Yes	Yes
Basic Search Capability	Yes	Yes
Parasolid Viewer	Limited	No
Customization flexibility	Low	High
Remote site administration	Yes (not totally integrated)	Yes (completely integrated)
Meta data definition wizard	Yes	No
(Cross, Vaidya, & Revels)		

As indicated by the matrix, both products have their own advantages. One quality not listed in the matrix is current certification for use on government computers. The 88th Communications Group at Wright Patterson Air Force Base has approved the JGAI product while Share Point is not. As with any product or service, the selection criteria should be based on the specific needs and goals of the organization.

Overall, the DR satisfied all requirements. The intent was to have a proof-of-concept that demonstrated the capabilities for a collaborative environment which allowed for the storage of technical data that is available to other programs. Additionally, the ability to view different types of geometric files (i.e. graphics) was demonstrated through the parasolids viewer. The successful application led to the development of a user manual, guidance, and policy. This collaborative environment is now used operationally within AFRL/VA.

5. LESSONS LEARNED

Each program presents new challenges as well as experiences that will improve the approach for future programs. Some of these areas include (a fuller discussion follows below):

- Overall approach in management
- Program objectives
- Obtain feedback and responding to changing user needs
- User involvement
- Product integration into daily organizational operations
- Use of demonstrations
- Imposed constraints
- Use of legacy tools

The overall approach in management to a program with multiple parts that are designed as independent tasks is to ensure the focus on the overall objectives of the organization is not lost. By having all of the tasks defined within a one program directed by a single organization, an integration perspective can be kept while each portion is completed independently. The utilization of UDRI as the "integrating" body allowed centralized control over all of the processes.

The program objectives were approached in manageable incremental steps. Some programs are touted to be "The Solution". In this program, aggressive and achievable steps were used to show the progress of each of the tasks. Demonstrable capabilities were used as metrics. At each of these points, feedback from the user groups was used to give both guidance and direction. This approach assured the acceptance by all those involved.

The project was successful due to the ability to obtain feedback and respond to changing user needs and changing criteria. As each task progressed, there were multiple demonstration, review, and feedback sessions. There was continual user involvement. The principal participants included the actual user group, government program manager, integrating contractor, and subcontractors. Each meeting highlighted the progress of the task, actual implementation of the software product(s), implementation feedback, and product improvements or program direction. This allowed the flexibility improve the product to enhance the current and future needs of the organization.

At the same time, there was product integration into the daily organizational operations where applicable. This direct usage provided valuable feedback to the product's technical development while establishing value. The direct input from the user also provided direct input for the tools, thus establishing "ownership" by the engineers. This adds not only user perspective but also the likeliness that the tools will be used and incorporated. With the results from exercising the tools, visibility was given to the program's achievements while the project is still ongoing.

The <u>use of demonstrations</u> illustrated project and gave perspective to the organization in regards to what can be accomplished and what toolsets are being developed to enhance the technology design and assessment processes. These demonstrations also aided management acceptance. The ability to show what can be done and the possibilities for the future shows not only progress, but also gives guidance to investment plans and strategies.

There are always <u>imposed constraints</u> to implement a program when the environment is selected prior to the start of a project. Specifically, JGAI's WPR was a product of choice at the inception of the contract. In Cross, et.al., an investigation showed the capabilities and limitations of not only WPR but also the other commercially available software. In this case, the solution was optimized with the product and not necessarily with the intended capabilities, use, or policies of the organization.

The incorporation of multiple <u>legacy tools</u> into a new system is always a challenge. Early access to the tools and the engineers that use them is important. Any delay may result in having less capability in the overall program. There are a variety of tools used to accomplish a single objective. In these cases, a ranked prioritization must be done in the down-select process. The objective is to sustain capability with a familiar tool as much as possible. Where it is not possible, viable alternatives must be introduced early on to gain acceptance.

Overall, the program was successful by adding capabilities to the technology assessment processes within AFRL/VA. The project approach made each task responsive to the organization's requirements while allowing "ownership" by the end-user. The ability to demonstrate and integrate the assets during the development provided opportunities for "real-world" feedback to improve the product or shift the direction to better fit the organization's objectives and needs.

6. RECOMMENDATIONS

The focus of the current SBRD effort has been on development of tools and the environment. The ability to link analytical and development tools in a single environment was developed and exercised. Additionally, the ability to work in a collaborative environment while transferring and storing knowledge, data, and tools was demonstrated. This is consistent with the published planning document for SBRD, fulfilling the first year recommendations (Revels & Gentner). The recommendations focus on the SBRD investment strategy and the specific tools developed in this program.

6.1 Investment Strategy

The investment plan for Year 2 concentrates on integration for results. According to Revels & Gentner, there is a need to develop and integrate analytical tools in a collaborative environment that will allow the transfer of data, knowledge, and tools. This environment should also enhance the necessary links between the technology development and mission simulations.

An analytical and decision-making tool should be integrated in this environment. This is currently in progress under the Adaptive Evaluation and Requirements Optimization (AERO) program. The development should aid in the effort to handle emerging technologies and deliver risk assessments to decision-making authorities.

Alignment with industry partners is an important aspect to becoming effective and efficient in the technology development and assessment process. Avenues should be explored to develop and acquire common tools used by airframe developers. This integration should be done with consideration of the goals of AFRL and the industry partner. A collaborative development and integration would be the optimal approach.

Additionally, external collaborations should be explored. An investment into programs that will tie organizations from not only AFRL but also within the Aeronautical Systems Center (ASC) together into a collaborative environment is necessary. The tie-in with ASC will give an end-to-end systems engineering approach. In essence, this will combine the processes that will follow technology from inception through acquisition, operations, and sustainment within a single environment or an environment of environments.

These three recommendations are a continuation down the path defined in the Strategic Investment Plan (Revels & Gentner). The ability to integrate decision-making tools, industry tools, and the acquisition environment enables synergy between organizations whose primary goal is to meet the needs and objectives of the operational community.

6.2 Tool Development and Implementation

Three major capabilities were developed under this program – Unified Geometry, Common Analysis Environment, and Collaborative Engineering Environment (including the Data Repository). Each tool is currently being utilized in AFRL/VA. These recommendations focus on the further development of these tools and how they should be implemented.

6.2.1 Unified Geometry

The Unified Geometry Final Report (Roach) recommends the continuing development of AMRaven. It is essential to make improvements to this geometry tool to enhance the capabilities of AFRL/VA. This tool has the potential to dramatically reduce the time it takes to model and assess air vehicle configurations.

Additionally, the capabilities should be fully integrated into the environment and exercised by both the developing engineers and the assessment teams. This proliferation in capabilities will help in a cultural shift as well as enable additional functionality and collaboration between organizations.

6.2.2 Common Analysis Environment

Exercising the CAE potential is key to effective and efficient technology assessment and planning. Utilization of the CAE should continue within AFRL/VA while also exploring the interconnectivity with other organizations both internally to AFRL (i.e. Propulsion and Structures) and externally including not only other government, but also industry and academia. Avenues to achieve a seamless link between Air Vehicles and Propulsion (AFRL/PR) Directorates should be the first step. Once this is established, this model can be replicated to add other directorates such as Materials and Manufacturing into the process.

With industry and academia, the common tools developed and used should be identified integrated. An approach is to choose a demonstration program to establish a “proof-of-concept” that will show the viability and usefulness to this approach. This will mitigate risks associated with this endeavor by taking incremental steps towards a fully integrated common environment.

6.2.3 Collaborative Engineering Environment

The ability share information within a program is vital to success. The implementation of WPRs is one method to such a collaborative environment. Collaborative workspaces are a growing industry and many tools are being developed for commercial use. As industry develops these programs, a comparative analysis should be done to assure the most effective environment is used to meet the needs of SBRD.

At this time, there is not one COTS product that will satisfy all the AFRL/VA needs. Building a custom solution within this environment may be another approach. Using this approach, care should be taken to integrate COTS components that will be available for the lifetime of the environment’s operation.

The DR should be maintained and updated with relevant programs, data, information, and tools. The current DR contains a small amount of information compared to its potential. Without updating this information, the DR will become outdated and be rendered useless to the engineer. Management of data is critical for the successful implementation and should be continued.

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Wright Brothers Institute
Energizing Collaborative R&D

Attachment 2

The Boeing Company Briefing Report

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AFRL-VA/WBI Collaboration Review

Patrick Cassidy (WBI Collaborator)

01-21-04

1

Overview

1. Geometry Conversion:
   Study Configuration → Wind Tunnel Model
   UDRI Wind Tunnel Model → CFD Model
2. Accelerated Analysis using COTS tools:
   - Model Center integrated with FLOPS
   - iSIGHT integrated with ACSYNT
3. LRS Work: Analysis and Geometry Development
4. Hypersonic Level 0 Tool
5. Potential Future Projects

2

The Air Force Research Lab (AFRL) Vehicle Assessment (VA), Wright Brothers Institute (WBI) collaboration program focused on four different aspects. The four aspects covered a broad range of issues that are being pursued within the aerospace industry, and especially focused on research thrusts and related problems encountered at the AFRL-VA/WBI. These were:

1. Geometry Conversion
2. Accelerated Analysis
3. Analysis and Geometry Development
4. Hypersonics

The geometry conversion issues that the AFRL-VA/WBI was experiencing were: conversion in accepting and utilizing "legacy" CAD model data from industry; and conversion of a University of Dayton Research Institute (UDRI) wind tunnel model into a CFD gridder compatible model.

AFRL-VA/WBI was interested in accelerated analysis, especially using Common-Off-The-Shelf (COTS) tools, such as Phoenix Integration's Model Center and Engineous Software's iSIGHT multi-disciplinary optimization (MDO) environments, and how they could be integrated with one of their tools FLight Optimization and Programmed Simulation (FLOPS). Another simulation code that was considered was AirCraft SYNThesis (ACSYNT), which has been highly utilized within the aerospace industry.

A specific focus of AFRL-VA/WBI in the realm of Analysis and Geometry Development was regarding the Long Range Strike (LRS) program. The user community was interested in methodologies that would allow rapid analysis and geometry creation.

Finally, the AFRL-VA/WBI was interested in the latest developments concerning Hypersonic Level 0 sizing tools. As a simulation code, this too could be later considered for integration with MDO environments, as well as geometry tools.

A number of potential future projects are listed in this presentation, to provide some glimpse as to where potential future thrusts may lie.

Closing Remarks

- Collaboration with AFRL-VA / WBI provided unique perspective and garnered excellent insight into the requirements, motivations, and objectives of the advanced concepts arena.
- These requirements, motivations, and objectives are of a different pace and scope than that experienced from within industry.
- It is vitally important to promote and maintain this perspective, so as to maximize performance and return on long-term objectives for both the government and industry.

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The closing thoughts on the completed effort.

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Attachment 3

Georgia Institute of Technology Briefing Report

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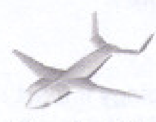
Technology Assessment of Medium-Range STOL Transport

(MrSTOLT)

conducted in fulfillment of the
following contract:

"Technology Assessment Methodology Applied to a UCAV Concept: A GaTech - AFRL/VA Collaboration"

Contract Number: 1606W33



Jointly conducted by:

Georgia Institute of Technology, Aerospace Systems Design Laboratory (ASDL)
Principal Investigator: Dr. Dimitri Mavris
Technical Lead: Dr. Danielle Soban

Air Force Research Lab/VAAA
Technical Lead: Mr. Cale Zeune

Presentation Outline

Introduction and Motivation
- Study Goals
- Study Workpath

Baseline Configuration
- Configuration Presentation-MrSTOLT
- Modeling of Baseline
- Validation of Baseline

Tools & Methods
- Overview of Technology Impact Forecasting (TIF)
- Response Surface Methodology
- Probabilistic Modeling
- Infusion of Technologies and Technology Scenarios
- Analysis Techniques

Contains Proprietary Information

Georgia Tech

ASDL

Presentation Outline

Technology Scenarios
- Selection of Technologies
- K_factors and Responses
- Scenario Determination
- Selection of K_factor Distributions and Assumptions

Results and Conclusions
- Pareto Analysis
- Analysis of Variance (ANOVA) Analysis
- Technology Tradeoff Environment
- Probabilistic and Risk Analysis
- Analysis and Conclusions